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Trace Elements in Meconium from Preterm and Full-Term Infants

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Abstract. Meconium samples from 23 preterm infants (birth weight = 1,097 ± 359 g; gestational age 29 ± 3 weeks, mean ± SD) and 27 full-term infants (3,453 ± 476 g; 39.5 ± 1 weeks) were analyzed for zinc, copper, manganese, chromium and iron by atomic absorption spectrometry. Compared to meconium from preterm infants, full-term infants had an elevated ($p < 0.05$) total excretion (μg) of zinc (957 ± 545 vs. 503 ± 506), copper (245 ± 256 vs. 128 ± 94) and manganese (62 ± 55 vs. 29 ± 29), but not iron (190 ± 147 vs. 332 ± 532) or chromium (0.4 ± 0.19 vs. 0.75 ± 1.0). Two preterm infants had high losses (1.5 and 2 mg) of iron in their meconium. Zinc, copper and manganese losses into meconium appear to increase with gestation, whereas iron and chromium losses occur early in gestation and may be reabsorbed by term.

Introduction

Meconium is the odorless greenish-black content of the fetal gut, present during intrauterine life and passed within the first few days after birth. Proteins, lipids and other components [1, 2] have been examined, but little work has been done on its mineral content. While the mineral content of meconium has been reported for full-term infants [3], we are not aware of any publications examining trace elements in the meconium of premature infants. Stores of certain trace elements are known to be low at birth in very low birth weight preterm infants [4] and we wondered whether part of these potential stores were being lost into the gut. Therefore we examined the meconium from 40 infants, 23 of whom were preterm and less than 1,500 g at birth.

Methods and Materials

All stools were collected from 27 healthy full-term infants (birth weight = 3,453 ± 476 g; gestational age 39.5 ± 1 weeks, mean ± SD) and 23 preterm infants

(1,097 ± 359 g; 29 ± 3 weeks) from birth until the appearance of transitional stools. Transitional stools were defined as those stools with texture or color change compared to the dark green viscous meconium. Initial feed (parental alimentation, formula or breast milk) was recorded for each infant from hospital charts. Meconium was scraped off diapers using acid-washed polyethylene funnels or Teflon-coated spatulas. All stools were assayed for blood (Hematest, Miles Laboratories Ltd.) and then placed in Falcon tubes for preservation at −20 °C. All samples within the collection period for each infant were pooled.

Prior to analysis each sample was thawed, wet weight recorded and then dried at 65 °C overnight. At that time, dry weight was recorded and 0.5–0.8 g of sample was transferred to a 15-ml platinum crucible in preparation for ashing. Samples were dry-ashed at 450 °C for 16 h (Fisher 'Isotemp' muffle furnace, Model 184) and cooled for 1 h. Five drops of 'Suprapur' HNO_3 were added to each sample. After 30 min samples were decanted into 10-ml volumetric flasks with 5 ml of 1 *M* HNO_3 'Suprapur' grade (E. Merck, Darmstadt, FRG) and brought up to final volume with deionized water having a resistance of more than 18 MΩ/cm (Barnstead purification system, Barnstead Co., Boston, Mass.). Because no certified fecal standards are available, National Bureau of Standards certified oyster tissue (SRM 1566) was analyzed in order to assess accuracy. Certified and analyzed values (μg/g dried tissue, n = 10) were: zinc, 852 ± 14 vs. 830 ± 26; copper 63 ± 3.5 vs. 73 ± 14; manganese 17.5 ± 1.2 vs. 19.6 ± 2; iron 195 ± 34 vs. 200 ± 45; chromium 0.69 ± 0.27 vs. 0.68 ± 0.1. Diapers (n = 4) were wet-ashed with nitric acid and analyzed for all trace elements. Iron in diapers was found to contribute less than 1% of total iron in meconium, whereas other metals were not found at all.

For assay of zinc, copper, manganese and iron, samples were analyzed by flame atomic absorption. For chromium, analysis was done by flameless atomic absorption using a model 2380 Perkin-Elmer atomic absorption spectrophotometer and HGA-300 graphite furnace with deuterium arc background correction.

Students t tests were applied to assess differences in trace element concentrations between groups [5] and within the preterm group according to whether or not they were respirated. One-way analysis of variance was used to determine differences according to initial feed. Significance was assigned to $p < 0.05$.

Results

Table 1 presents the zinc, copper, manganese, iron and chromium excreted in the meconium of preterm and full-term infants. There were no differences according to gender in any trace elements measured in meconium, therefore all results were pooled. The average moisture content of meconium was 68% in both groups with preterm infants passing 3.2 ± 3.0 g meconium and full-term infants passing 8.9 ± 4.6 g of meconium ($p < 0.05$). The average time of collection was 3.4 ± 1.5 days (range 2–6 days) for preterm infants and 1.7 ± 0.6 days (range 1–3 days) for full-term infants. Stools were first collected at 1.7 ± 0.6 days (range 1–3 days) for full-term infants and at 3.1 ± 1.5 days (range 1–5 days) for pre-term infants. One infant passed 25 mg of iron in his meconium

Table 1. Trace element excretion in total (μg) and by body size (μg/kg) in Meconium of preterm and full-term infants (mean ± SD)

Element		Preterm (n = 23)	Full-term (n = 27)
Zn	μg	503 ± 506*	957 ± 545
	μg/kg	444 ± 287	287 ± 176
Cu	μg	128 ± 94*	245 ± 256
	μg/kg	119 ± 91	74 ± 81
Fe	μg	332 ± 532	190 ± 147
	μg/kg	311 ± 488*	59 ± 56
Mn	μg	28 ± 29*	62 ± 55
	μg/kg	24 ± 23	19 ± 19
Cr	μg	0.75 ± 1.0	0.40 ± 0.19
	μg/kg	0.6 ± 0.72*	0.12 ± 0.01

* $p < 0.05$ between groups.

and was the only infant to test positive for fecal occult blood. The iron concentration for this infant was not included in the results.

Within both groups there was no difference in the excretion of trace elements according to the initial feed and within the preterm group, whether or not the infants were on a respirator.

Discussion

The trace element concentrations reported for full-term infants in the present study are comparable to those reported by Kopita and Shwachman [3] for copper, iron, manganese and zinc. Chromium concentrations have not been previously reported.

Total excretion of zinc, copper and manganese was higher in the meconium of full-term infants compared to that of preterm infants (table 1). This suggests that the concentration of these minerals in meconium increases throughout gestation. The endogenous excretion of zinc occurs in the small intestine [6] and has been reported to be quite pronounced in pre-term infants [7]. This may explain why pre-term infants are in negative zinc balance early in life [8] and why we found higher amounts of zinc in meconium compared to other trace elements.

The iron and chromium content of total meconium did not differ between the two groups, but there was a difference in concentrations per kilogram body weight. Losses of these metals into the gut occur early in gestation as full-term infants do not lose more iron or chromium. Alternatively iron and chromium may be reabsorbed later in gestation. Two preterm infants excreted particularly high levels of iron (1.5 and 2 mg) in their meconium. We previously reported high iron excretion in the first stool of a preterm infant who was being parenterally fed [9]. There may be a relationship between low iron stores [4], high iron loss in meconium and the susceptibility of preterm infants to anemia [10].

We are not certain which tissues contribute trace elements to meconium. Meconium is a collection of debris including desquamated cells of the gastrointestinal tract and skin, swallowed amniotic fluid and various intestinal secretions [2]. The greenish color appears to be bile pigment [1]. This suggests that the maturing liver may contribute iron, zinc and copper [4] to meconium via biliary excretion.

Concentrations of zinc, copper and iron in the amniotic fluid appear to be higher at 20 weeks of gestation [11, 12] than at term [13, 14]. Nothing is known about changes in manganese and chromium concentration through gestation, except that the chromium content of amniotic fluid is very low [15]. The contribution of trace elements in amniotic fluid to meconium would depend on the amount swallowed by the fetus which is now known. Irrespective of their source, the excretion of trace elements, particularly iron, in the meconium may play a role in postnatal development.

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